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DISCUSSION OF CONSUMPTIVE USE OF WATER ON IRRIGATED LAND

(Published in November, 1951)

By Clyde E. Houston, and Wayne D. Criddle

IRRIGATION AND DRAINAGE DIVISION

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Technical Division	*Proceedings-Separate Number*
Air Transport	108, 121, 130, 148, 163 (Discussion: D-23, D-43, D-75, D-93, D-101, D-102, D-103, D-108)
City Planning	58, 60, 62, 64, 93, 94, 99, 101, 104, 105, 115, 131, 138, 148, 151, 152, 154 (Discussion: D-16, D-23, D-43, D-60, D-62, D-65, D-86, D-93, D-99, D-101, D-105, D-108, D-115)
Construction	130, 132, 133, 136, 137, 145, 147, 148, 149, 150, 152, 153, 154, 155, 159, 160, 161, 162 (Discussion: D-3, D-8, D-17, D-23, D-36, D-40, D-71, D-75, D-92, D-101, D-102, D-109, D-113, D-115)
Engineering Mechanics	122, 124, 125, 126, 127, 128, 129, 134, 135, 136, 139, 141, 142, 143, 144, 145, 157, 158, 160, 161, 162 (Discussion: D-24, D-33, D-34, D-49, D-54, D-61, D-96, D-100)
Highway	138, 144, 147, 148, 150, 152, 155, 163 (Discussion: D-XXVIII, D-23, D-60, D-75, D-101, D-103, D-105, D-108, D-109, D-113, D-115)
Hydraulics	107, 110, 111, 112, 113, 116, 120, 123, 130, 134, 135, 139, 141, 143, 146, 153, 154, 159 (Discussion: D-90, D-91, D-92, D-96, D-102, D-113, D-115)
Irrigation and Drainage	129, 130, 133, 134, 135, 138, 139, 140, 141, 142, 143, 146, 148, 153, 154, 156, 159, 160, 161, 162 (Discussion: D-97, D-98, D-99, D-102, D-109)
Power	120, 129, 130, 133, 134, 135, 139, 141, 142, 143, 146, 148, 153, 154, 159, 160, 161, 162 (Discussion: D-38, D-40, D-44, D-69, D-70, D-71, D-76, D-78, D-79, D-86, D-92, D-96, D-102, D-109, D-112)
Sanitary Engineering	55, 56, 87, 91, 96, 106, 111, 118, 130, 133, 134, 135, 139, 141, 149, 153 (Discussion: D-29, D-37, D-56, D-60, D-70, D-76, D-79, D-80, D-84, D-86, D-87, D-92, D-93, D-96, D-97, D-99, D-102, D-112)
Soil Mechanics and Foundations	43, 44, 48, 94, 102, 103, 106, 108, 109, 115, 130, 152, 155, 157 (Discussion: D-86, D-103, D-108, D-109, D-115)
Structural	133, 136, 137, 142, 144, 145, 146, 147, 150, 155, 157, 158, 160, 161, 162, 163 (Discussion: D-51, D-53, D-54, D-59, D-61, D-66, D-72, D-77, D-100, D-101, D-103, D-109)
Surveying and Mapping	50, 52, 55, 60, 63, 65, 68, 121, 138, 151, 152 (Discussion: D-60, D-65)
Waterways	120, 123, 130, 135, 148, 154, 159 (Discussion: D-8, D-9, D-19, D-27, D-28, D-56, D-70, D-71, D-78, D-79, D-80, D-112, D-113, D-115)

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DISCUSSION

CLYDE E. HOUSTON,[4] A.M. ASCE.—Mr. Criddle has given an excellent presentation of a subject which should receive primary consideration by present-day irrigation engineers and planners. Past experience has shown that there is more to building a successful irrigation project than the construction of great dams, control works, and canals. There is need for concentrated study of the actual use of the water by crops on the farm. If, as a result of inaccurate calculations or inefficient water use, the cost of dams and canals cannot be repaid, what good are they but as monuments to poor planning?

To Mr. Criddle's list of "Factors Affecting Agricultural Use" might be added a sixth factor—improved crop varieties. With the advent of hybrid corn and its increased yield probably comes an increase in consumptive use. Improved alfalfa varieties on irrigation experimental plots at Reno, Nev., indicate an increased consumptive use of water with an increased yield. As improved irrigation practices take place to influence crop yield materially there may be an increase in the consumptive use of water.

The period of small, simple, and relatively inexpensive water projects has closed and a period of large, complex, and relatively costly undertakings has opened. It should be recognized that projects of various types will increase still further in size, complexity, and cost. Furthermore, the supply of water for the use of these projects is limited. Under these circumstances it is clear that effective control and efficient use of water must be obtained for maximum utilization and the greatest total benefit. Consumptive-use determinations are fundamental to a sound, permanent, and profitable irrigation agriculture.

WAYNE D. CRIDDLE[5].—In suggesting that the introduction of improved crop varieties will increase consumptive use, Mr. Houston is entirely correct. Any increase in crop yield—whether it is caused by the use of improved varieties, higher fertility levels, or better irrigation and management practices—will tend to increase the consumptive use of water by the crop, although not in direct proportion to yield increases. Also, as shown by the work of the Soil Conservation Service at Prosser, increasing the frequency of irrigation and maintaining the soil moisture at a higher level will greatly increase the consumption of water, although yields may not be greatly influenced.

The data on the consumptive use of water were based on what the writer believes to be approximately average conditions for the areas, both as to crop yields and irrigation practices. Any general increase in yield or change in irrigation practice for any large area usually comes slowly. Therefore, the data presented in the paper should be valid for a number of years.

Since the paper was written in 1950, much additional information has been gathered on the peak use rate. Current studies at various locations in the

NOTE.—This paper by Wayne D. Criddle was published in November, 1951, as *Proceedings-Separate No. 98*. The numbering of footnotes and tables in this Separate is a continuation of the consecutive numbering used in the original paper.

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West indicate the approximate range of the daily rate at which water is used by crops. The consumptive-use rate for any one day, or the average over a short series of days, can be considerably higher than the average daily rate for an entire month. Likewise, use during the peak month is much higher than the average monthly rate during the entire growing period. Frequency of irrigation depends on the length of time that the water stored in the soil will meet the plant needs, or on how much water the soil will hold and how fast it is used. Therefore, the less water that can be stored in the root zone at each irrigation, the more frequent the irrigation must be, assuming that the use rate remains the same. Also, the less water that can be stored at each irrigation and the more frequent the irrigation, the larger the irrigation system must be to meet the crop needs during periods of high use.

Studies have shown the relationship between the daily use of water by crops during short peak periods and the average during a peak month. This relationship was used in constructing Table 3. By considering the char-

TABLE 3.—PEAK CONSUMPTIVE-USE RATES FOR THE DESIGN OF IRRIGATION SYSTEMS

Computed peak monthly use, in inches	PEAK DAILY CONSUMPTIVE-USE DESIGN RATES, IN INCHES PER DAY							
	Depth of water to be stored[a]							
	1 in.	2 in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.
3.0	0.16	0.14	0.12	0.11	0.11	0.10	0.10	0.10
4.0	0.21	0.18	0.17	0.15	0.15	0.14	0.13	0.13
5.0	0.27	0.23	0.21	0.19	0.18	0.17	0.16	0.16
6.0	0.32	0.27	0.25	0.23	0.22	0.21	0.19	0.19
7.0	0.37	0.32	0.29	0.27	0.25	0.24	0.23	0.23
8.0	0.43	0.36	0.33	0.31	0.29	0.27	0.26	0.26

[a] Depth of soil moisture to be replaced in the crop root zone by each irrigation.

acteristics of the soil in the crop root zone and by knowing, or computing, the peak monthly consumptive-use rates of the crops, Table 3 might be used to design an irrigation system with adequate capacity to meet the varying crop needs.

An example of the use of Table 3 follows: The design capacity of an irrigation system might be desired, in which the peak monthly use of the crop is 6 in. The soil, which is light-textured and well-drained, will hold only 1 in. of water between wilting point and field capacity for each foot of soil depth. Under the existing conditions, the rooting depth of the crop is 3 ft and the irrigation water must be applied by the time two thirds of the available soil moisture has been extracted. Thus, a 2-in. application would be required at each irrigation. From Table 3 it may be seen that with a peak monthly consumptive-use requirement of 6 in. and where only 2 in. can be stored at each irrigation, the system must be able to apply 0.27 acre-in. per acre each day. The irrigation interval could not exceed about eight days. However, irrigation water cannot be applied on a field basis without some loss. A good irrigation efficiency is generally considered to be about 75%. Thus, the

system in this example must have a capacity of 0.27/0.75, or 0.36 acre-in. per acre per day, which is about 6.75 gal per min of continuous flow for each acre of land.

If the soil in the example had been deep, with a high water-holding capacity from which 7 in. of water could safely be withdrawn between irrigations, the average daily peak use would have been 0.19 acre-in. per acre per day. If applied at 75% efficiency, this would have required a system capacity of only 0.25 acre-in. per acre per day, or 4.7 gal per min of continuous flow for each acre of land.

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